

A New Approach for Acquiring Skills Towards Undergraduate Research: A Progress Review

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ABSTRACT

In recent years, a gradual transition from passive teaching to active learning has intensified in higher education. Critical thinking and deep learning is promoted, as opposed to surface learning. The Teaching Excellence Framework guidance for higher education associates learning with research, thus research skills acquisition is fundamental. An innovative collaborative research project, leading to individually composed assignments, was implemented in a research methodology module, aiming at developing an undergraduate research skill set and writing performance. The results were satisfactory showing positive student response to the newly implemented approach. Critical thinking, deep learning, autonomy, peer-support and collaboration are mostly what the undergraduate students can benefited from, through this innovative learning approach.

Keywords

Critical thinking | Deep learning | Research methodology | Undergraduate research

INTRODUCTION

The current focus on active learning has displaced the emphasis on passive teaching in many contemporary educational systems (Almarghani and Mijatovic, 2017; Bohaty *et al.*, 2016). When students are taught a subject with passive teaching, they are not exposed to critical thinking and deep learning. Thus they partially and often superficially conceive the subject matter. Surface learning describes those students who perform well in multiple choice questions rather than other forms of assessment, which require approaches for deep learning (Scouller, 1998). With active learning, when a student understands the subject, he/she is able to discuss it in depth unlike those who merely learn the answer to a question without expanding upon the topic (Lujan and DiCarlo, 2006; Ofstad and Brunner, 2013). Group discussions and debates are associated with deep learning (Tsaushu *et al.*, 2012).

Another issue with passive teaching is that the instructor will not be next to the student after graduation for guidance in solving problems. Conversely, concentrating on learning leads to the development of critical thinking and a different way of perceiving and synthesizing relevant information necessary to acquire and apply expertise (Lujan and DiCarlo, 2006; Ofstad and Brunner, 2013; Behar-Horenstein *et al.*, 2005). The roadmap to focusing on learning is through research, as implicated by the Teaching Excellence Framework (TEF)

guidance for higher education (Department for Business, Innovation and Skills, 2015).

Developing research skills towards effective learning of broader material advances academic opportunities but requires time and effort to develop (Murdoch-Eaton *et al.*, 2010).

Improving metacognitive abilities in the higher education environment is key to the development of research skills (Rahman *et al.*, 2014). The students, through research, comprehend the material in depth and are equipped for future acquisition of knowledge, as lifelong learners. It is imperative for graduates of any scientific field to academically search literature to find answers to work-related issues when they arise. This is even more essential with the availability of open access journals.

During their final year of studies, most undergraduate students complete a dissertation project. This can be either experimental or a review of literature. In both cases, they have to reference scientific peer-reviewed journals and textbooks. Thus, it is important to incorporate research methodology studies before or in parallel to their dissertation project. From our experience, reports and essays are not analysed and referenced sufficiently in the first year of studies. The structure of scientific journal articles poses a difficulty to students in comprehending and using them correctly. This can be explained since it is the first encounter of the students with scientific research articles.

A new approach to advance the undergraduate research skillset has been implemented in the research methodology module, embedded in the curriculum of a Dental Technology programme at a University in the North of England. The module is delivered during the second year of studies. Apart from learning the basic principles of research, which are delivered through a classic learning process in this module, the new approach is interactive and encourages peer collaboration.

It was hypothesized that the students would perform better than in their first-year assignments and become autonomous and competent in their research during their research methodology module.

MATERIALS AND METHODS

Article Type Structure Analysis

A research article on dental materials was presented to the students in the course and its structure was thoroughly analysed: abstract, introduction, materials and methods,

results, discussion, conclusions, references. Then, each student was asked to provide a descriptive title for every paragraph of the article (paragraph descriptive title: PDT). As a formative assessment, the students interactively peer-reviewed each PDT that they had assigned to each paragraph of the article and selected the most appropriate, stating their rationale.

Review articles were also introduced to the students, highlighting their limited structure as opposed to the structure of the research articles. Subsequently, systematic review articles and their structure, being similar to that of research articles (abstract, introduction, materials and methods, results, discussion, conclusions, references) were analysed and thoroughly explained.

Summative Assessment Rationale

The summative assessment for the research methodology module was designed to simulate a collaborative skill set development, parallel to the writing experience of multiple authors, as in peer-reviewed scientific journals. This assessment was a written assignment of the students on a dental materials topic, based on a systematic review format. The students were provided with a dental topic and we discussed in class the structure of the assignment: abstract, introduction, materials and methods, results, discussion, conclusions, references. We also gave directions on how to research the specific topic. The directions included search engines, appropriate use of keywords, as well as how to screen the search results. The instructors provided constant feedback throughout the process.

Participants

Having sixteen authors-students in each of the two groups in the course led us to the decision of allocating one research subtopic to each student. Each subtopic's title served as the PDT, as was discussed earlier. These subtopics comprised the introduction and the discussion parts. The sixteen students were divided into eight pairs. Each pair shared the same subtopic-PDT (one student researching for the introduction and the other for the discussion). Thus, the introduction and the discussion parts comprised of eight paragraphs each, sharing the same subtopics-PDTs in the same paragraph sequence.

Provision of the Required Information

Working together (the pair), they provided the relevant information for the introduction and the discussion (by highlighting the relevant parts in scientific journal articles). In the introduction part, the students provided the relevant information for a literature review

introducing the subtopic, whereas in the discussion part, they provided the relevant information for a more in-depth review of the literature, in the form of discussion of published outcomes. Ideally, the students provided published outcomes that contradicted each other.

After researching the assignment topic, the students provided a subtopic-PDT, which they would prefer to research either for the introduction or for the discussion section. Two or three subtopics-PDTs were submitted by each student, to address potential similarities among the responses of the students. After discussion with the students and the tutors, each pair of students was finally assigned a subtopic-PDT, while each student of the pair group was assigned the introduction or discussion part, accordingly.

Each student, after extensive research, was asked to electronically submit a folder to the tutors, containing at least 7 scientific journal articles related to their subtopic-PDT. The parts of each scientific journal article containing the relevant piece of information to the subtopic-PDT information were highlighted by the author -student. These could be as short as one sentence long and should be the parts that the student would actually use as references towards composing the specific paragraph of the assignment.

Procedure for Independent Assignment Writing

All submitted folders containing the highlighted articles of the authors-students had been numbered in the paragraph sequence of the final assignment and were available on the online Learning Management System (LMS). Each folder, in addition to its sequence number, included the name of the author-student and the part of the article (introduction/discussion), which it addressed, to facilitate questions to be answered online by the peers (authors-students) via the LMS platform.

The students wrote the assignment independently using the information in the LMS. Each student opened each folder in the LMS in the corresponding paragraph sequence, read the highlighted parts of each of the seven articles and composed a paragraph relevant to that subtopic-PDT, referencing at least four of these seven articles.

The materials and methods section, two paragraphs long, had to be completed stating the search engines and keywords that were used. All students used the same search engines, while the keywords were those that each student had individually used in his/her subtopic-PDT research. The results section, one paragraph long, was filled by each student upon completion of their assignment, stating the number of research articles that were required to reference his/her

assignment (minimum 64 to maximum 112). The conclusions section, one paragraph long, was written individually by each student, demonstrating his/her familiarisation with the assigned topic. The reference list comprised of minimum 64 to maximum 112 scientific journal articles. The total amount of paragraphs within the assignment was 20 (Figure 1).

A 10-minute scientific poster was presented by each individual student after the assignment submission according to the instructions provided by the tutors. The individual posters were presented to the respective cohort of students in one session.

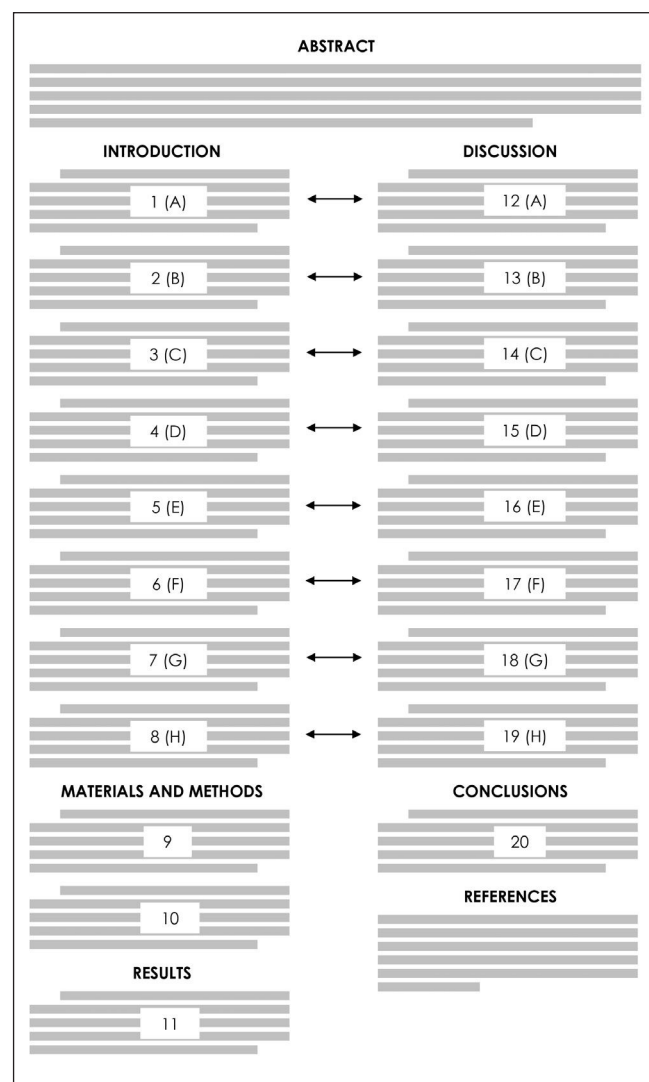


Figure 1. The collaborative research project with the individually composed assignments. The numbers represent the sequence of each paragraph in the assignment. Same paragraph letters (in the parentheses) represent same subtopics-PDTs shared in the introduction and the discussion parts (arrows additionally indicate this sharing).

RESULTS

The highlighted parts of the articles were evaluated by the two

authors of the present study, regarding their relation to the subtopic-PDT. The expected number of the submitted articles for each of the two groups was 112 (7 articles multiplied by 16 subtopics-PDTs).

In the first group, 101 articles were submitted, due to one student not submitting the articles and two others not providing all seven required articles. The highlighted parts of 77 articles were relevant to the corresponding subtopics-PDTs, whereas those of 5 articles were not. In 14 articles, the abstract section was highlighted, with the overall highlighted content being relevant to the corresponding subtopic-PDT. An article's abstract was highlighted, while at the same time all highlighted parts were irrelevant to the corresponding subtopic-PDT. There were 4 articles that were not sourced from a scientific peer-reviewed journal (non-credible-source). [Figure 2](#) presents the correlation of the sourced articles to the instructors' specified standards (Group A).

In the second group, 103 articles were submitted, due to four students not providing all seven required articles. The highlighted parts of 60 articles were relevant to the corresponding subtopics-PDTs, whereas those of 16 articles were not. In 16 articles, the abstract section was highlighted, with the overall highlighted content being relevant to the corresponding subtopic-PDT. An article's abstract was highlighted, while at the same time all highlighted parts were irrelevant to the corresponding subtopic-PDT. There were 3 articles that were not sourced from a scientific peer-reviewed journal (non-credible-source). In this group, 7 articles (provided by one student) were not highlighted.

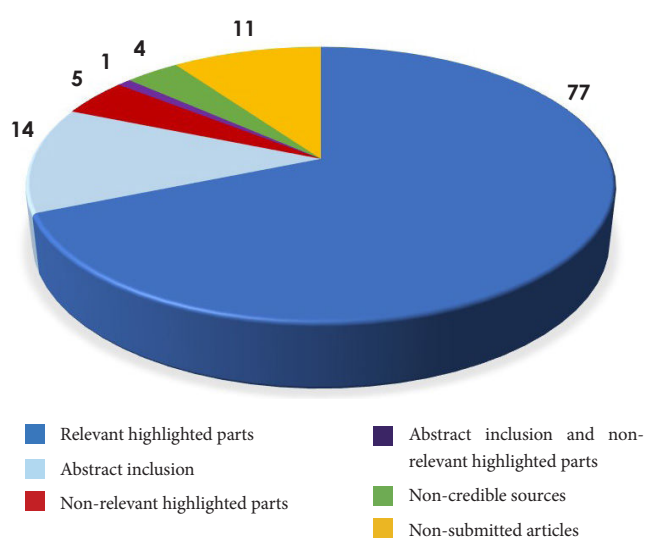


Figure 2. Pie-chart designating the correlation of articles sourced to the instructors' specified standards (Group A).

[Figure 3](#) presents the correlation of the sourced articles to the instructors' specified standards (Group B). The module marking and moderation (internal and external) has not been finalised at the stage of this publication as the module has not been completed yet.

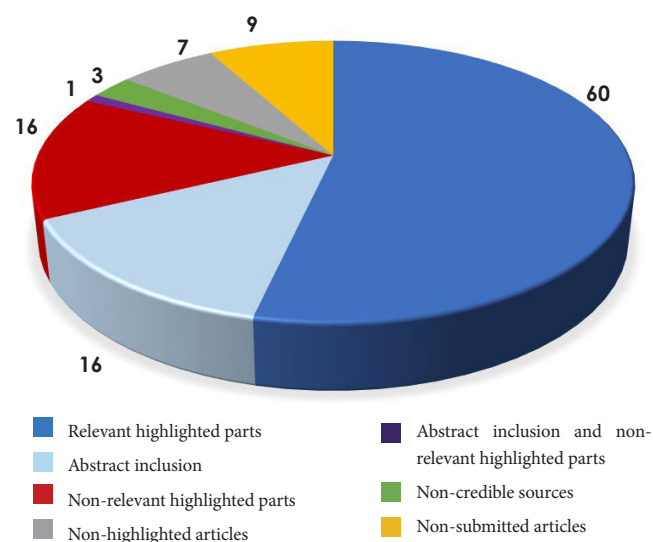


Figure 3. Pie-chart designating the correlation of articles sourced to the instructors' specified standards (Group B).

DISCUSSION

One of the most frequent and important issues when students write an assignment, ranging from simple reports to research dissertations, is the lack of structure. Aiming at overcoming it, we introduced the basic principles of the most accepted, scientifically recognized, structured formats. A dental related research article published in a peer-reviewed journal was selected, presented and analysed with the students. The students were assigned the task to generate paragraph descriptive titles (PDTs), aimed to familiarise them with the structured format of each part of the research article. The peer-review process was selected as a formative assessment, being truly beneficial in the learning process ([Liu, 2002](#)).

The systematic review approach for the students' assignment was selected to emphasise the abovementioned structure: abstract, introduction, materials and methods, results, discussion, conclusions, references. However, although the structure was based on systematic review, the content of each section was differentiated for student learning.

The introduction and the discussion parts shared the same subtopics-PDTs, in the same paragraph sequence.

The reason behind this concept was to emphasise the difference of content between those two sections. The collaboration of two students working in the same paragraph subtopics-PDTs of the introduction and the discussion part, proved to be helpful, according to feedback from students. As a proof of this collaboration, many articles that were used in the introduction part were also used in the discussion part, with the limitation of not using more than three common articles out of the seven submitted.

The content design of the materials and methods, as well as the results section, aimed at promoting the students' learning of basic principles regarding scientific search engines (e.g. using Boolean operators), keyword selection and correct article screening evaluating the retrieved results. The search engines used by all students were selected jointly with the students after class discussion and they were the same for all submitted assignments. On the other hand, the large amount of students-authors in this research procedure presented a limitation in defining and selecting the keywords jointly before starting the research. Thus, each student supplied the keywords individually for his/her research of the corresponding subtopic-PDT. In the results section (as well as in the reference list), the number of articles used to reference the assignment was different for each student due to the option of using at least four out of the seven highlighted articles for each paragraph (minimum $4 \times 16 = 64$ to maximum $7 \times 16 = 112$).

The entire process of collaborative research offered the advantages of team work. Simultaneously, the constantly provided feedback by the tutors proved to be beneficial for the students as they were acquiring research skills. Imitating the writing of scientific journal articles, stimulated critical thinking as opposed to surface learning. The critical evaluation involved in the requirement of referencing multiple articles for composing a single paragraph became apparent throughout this research process.

The main benefit of the proposed learning approach is that although it is a collaborative research project, each student is solely responsible for his/her own work. Not only do the students conduct research on their own (i.e., individual subtopics-PDTs) and provide evidence of doing so (i.e., seven submitted research articles), but also the assignments are prepared individually. It is of great interest to note that although the information highlighted in the referenced articles was the same for all students' assignments, the final outcome of the individual assignments was different because of each student's approach, perception and further research of each subtopic-PDT.

It was interesting to note that some articles were highlighted in the abstract section. Instructions were given in the tutorials not to highlight abstracts, so highlighting abstracts was not anticipated by the authors of this article. This might have happened because of the succinct nature of the abstract sections, which draw the attention of non-experienced readers. On the other hand, the small number of highlighted articles that were not related to the corresponding allocated subtopics-PDTs might be due to the difficulty in comprehending such subtopics-PDTs at this level of study. The small number of non-credible sourced articles, non-highlighted articles and non-submitted articles was expected as a small number of students had a low level of attendance.

As the module has not been completed yet, the academic process of marking and moderation (internal and external) has not been finalised. Thus, further data can be collected and analysed to evidence the impact of this research methodology on undergraduate students. The poster presentation process implemented in the module led to very positive feedback by the students. The students stated that they found this process very helpful for evaluating their own poster presentation by self-reflection. The module's learning outcomes were met by this innovative research methodology approach as indicated by the Quality Assurance Agency for Higher Education ([Quality Assurance Agency for Higher Education, 2005](#)).

CONCLUSION

Most of the submitted assignments show satisfactory results, given that the students are starting as researchers. This new approach for acquiring skills for early undergraduate research promotes autonomy, critical thinking and deep learning, as well as peer-support and collaboration. Taking into account that this methodology is part of a long-term process, the results in terms of acquired research and writing skills will be shown and evaluated via their final year dissertation research project outcomes. However, the benefits are not only limited to achieving academic goals (dissertation project or academic career) but also in the development of an academically critical way of thinking and in researching to solve potential work-related issues in the future industry career of today's students.

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AUTHOR CONTRIBUTIONS

The authors confirm being the sole contributors of this work and approved it for publication.

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CONFLICT OF INTEREST STATEMENT

The authors declare that the research was conducted in the absence of any commercial or financial relationships that

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